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CLAIMS

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1. An ink consumption condition detection method for detecting an ink consumption condition in an ink container loaded in an ink jet recording apparatus having a recording head for jetting ink drops, wherein said ink consumption condition in said ink container is detected using a piezo-electric device having a piezo-electric element during a non-recording state of said recording head.

2. An ink consumption condition detection method according to claim 1, wherein said ink consumption condition in said ink container is detected using said piezo-electric device during a maintenance operation for cleaning said recording head.

3. An ink consumption condition detection method according to claim 1, wherein said ink consumption condition in said ink container is detected using said piezo-electric device during an operation for feeding or ejecting a recording medium, to which ink is jetted from said recording head, to or from said recording apparatus.

4. An ink consumption condition detection method according to claim 1, wherein said ink consumption condition in said ink container is detected using said piezo-electric device when power of said recording apparatus is turned on.

5. An ink consumption condition detection method according to claim 1, wherein said ink consumption condition in said ink container is detected using said piezo-electric device during a period from turning said recording apparatus off to a stop of said recording apparatus.

6. An ink consumption condition detection method according to claim 1, wherein said ink container is an ink cartridge loaded on a carriage for moving said recording head back and forth in a removable state, and said ink consumption condition in said ink cartridge is detected using said piezo-electric device during a period in which said carriage is stopped.

7. An ink consumption condition detection method

according to claim 6, wherein said ink consumption condition in said ink cartridge is detected using said piezo-electric device after a predetermined time lapses from the beginning of a stop state of said carriage.

8. An ink consumption condition detection method according to claim 1, wherein said piezo-electric device detects changes in acoustic impedance, thereby detects said ink consumption condition in said ink container.

9. An ink consumption condition detection method according to claim 1, wherein said piezo-electric element of said piezo-electric device has a vibration part, and said piezo-electric device detects changes in said acoustic impedance on the basis of counter electromotive force generated by residual vibration remaining in said vibration part, thereby detects said ink consumption condition in said ink container.

10. An ink consumption condition detection method according to claim 1, further comprising the steps of:

storing information of said ink consumption condition in said ink container detected by said piezo-electric device in a storage unit mounted on said ink container,

reading said information of said ink consumption condition stored in said storage unit, and

judging whether a detection of said ink consumption condition in said ink container should be executed or not on the basis of said read information of said ink consumption condition.

11. An ink consumption condition detection method according to claim 1, wherein said ink container is an ink cartridge loaded on a carriage for moving said recording head back and forth in a removable state,

said method comprising:

a consumption condition detection step of detecting, in a non-recording state of said recording head, said ink consumption condition in said ink cartridge by said piezo-electric device, and

a reconfirming step of redetecting said ink consumption

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condition in said ink cartridge by said piezo-electric device after detection of absence of ink in said ink cartridge by said consumption condition detection step.

12. An ink consumption condition detection method according to claim 11, wherein said reconfirmation step comprises:

a carriage moving step of moving said carriage after absence of ink in said ink cartridge is detected by said consumption condition detection step, and

a consumption condition redetection step of redetecting said ink consumption condition in said ink cartridge in a predetermined timing.

13. An ink consumption condition detection method according to claim 12, wherein said carriage moving step moves said carriage at a faster speed than a speed for moving said carriage during a recording operation.

14. An ink consumption condition detection method according to claim 12, wherein a shock is given to said ink cartridge during moving said carriage by said carriage moving step.

15. An ink consumption condition detection method according to claim 12, wherein said consumption condition redetection step is executed when a predetermined time passes after said carriage moving step ends.

16. An ink consumption condition detection method according to claim 12, wherein said consumption condition redetection step is executed during moving said carriage by said carriage moving step.

17. An ink consumption condition detection method according to claim 16, wherein said carriage moving step moves said carriage back and forth, and, when said carriage almost returns and moves from a forward path to a backward path, said consumption condition redetection step redetects said ink consumption condition.

18. An ink consumption condition detection method according to claim 16, wherein said carriage moving step moves said carriage back and forth, and, immediately after said

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carriage ends moving on a forward path and starts moving on a backward path, said consumption condition redetection step redetects said ink consumption condition.

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19. An ink consumption condition detection method according to claim 12, wherein said reconfirmation step is executed several times during moving said carriage by said carriage moving step, and presence or absence of ink in said ink cartridge is decided on the basis of detection results of said reconfirmation steps.

20. An ink consumption condition detection method according to claim 19, wherein said reconfirmation step is executed several times, and, when presence of ink is detected in said consumption condition redetection step more than a predetermined count, it is decided that ink exists in said ink cartridge.

21. An ink consumption condition detection method according to claim 19, wherein said reconfirmation step is executed several times, and presence or absence of ink in said ink cartridge is decided on the basis of a mean value of measured results of said consumption condition redetection steps.

22. An ink consumption condition detection method according to claim 1, wherein measuring timing of said ink consumption condition is controlled on the basis of an operation history of said ink jet recording apparatus.

23. An ink consumption condition detection method according to claim 22, wherein a measuring frequency is increased according to cumulation of operations of said ink jet recording apparatus.

24. An ink consumption condition detection method according to claim 23, wherein said cumulation of operations is a cumulative driving time of a carriage on which said recording head is loaded.

25. An ink consumption condition detection method according to claim 22, wherein a measurement of said ink consumption condition is executed immediately when said measuring timing of said ink consumption condition comes

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after a predetermined time elapses from a point of time when a carriage on which said recording head is loaded moves last.

26. An ink consumption condition detection method according to claim 22, wherein, when said measuring timing of said ink consumption condition comes before a predetermined time elapses from a point of time when a carriage on which said recording head is loaded moves last, measurement is executed immediately after said predetermined time elapses.

27. An ink consumption condition detection method according to claim 22, wherein, when said measuring timing of said ink consumption condition comes after a predetermined time elapses from a point of time when a carriage on which said recording head is loaded moves last, a measuring interval is shortened.

28. An ink consumption condition detection method according to claim 22, wherein, when said measuring timing of said ink consumption condition comes before a predetermined time elapses from a point of time when a carriage on which said recording head is loaded moves last, a measuring interval is increased.

29. An ink consumption condition detection method according to claim 23, wherein said cumulation of operations is a cumulative driving time of said recording head.

30. An ink consumption condition detection method according to claim 23, wherein said cumulation of operations is a measuring count of said ink consumption condition.

31. An ink consumption condition detection method according to claim 22, wherein a history memory installed in said ink jet recording apparatus or said ink container stores at least one of a cumulative time of operations of said ink jet recording apparatus and a cumulative measuring count.

32. An ink consumption condition detection method according to claim 31, wherein said history memory further stores past measurement histories using said piezo-electric device.

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33. An ink consumption condition detection method according to claim 1, wherein said piezo-electric device has a vibration part including said piezo-electric element, and wherein said piezo-electric device measures a periodic peak value of a waveform of counter electromotive force generated by residual vibration remaining in said vibration part by a predetermined number of said periodic peak values from a predetermined point of time, and said piezo-electric device measures more number of said periodic peak values than said predetermined number of said periodic peak values in subsequent detection of said ink consumption condition, and thereby detects said ink consumption condition.

34. An ink consumption condition detection method according to claim 33, wherein said periodic peak value of said waveform of counter electromotive force is measured by increasing said predetermined number of values from said predetermined point of time in accordance with increasing of a detection count of said ink consumption condition in the ink container, and thereby said ink consumption condition is detected.

35. An ink consumption condition detection method according to claim 33, wherein said ink jet recording apparatus or said ink container has a storage memory, and said storage memory stores a measurement history of said ink consumption condition of said piezo-electric device.

36. An ink consumption condition detection method according to claim 1, wherein said ink container is an ink cartridge loaded on said ink jet recording apparatus in a removal state.

37. An ink consumption condition detection method according to claim 1, further comprising a consumption condition calculation process of calculating said ink consumption condition in said ink container by calculating said ink consumption used in said ink jet recording apparatus, and

wherein said piezo-electric device detects whether an ink level in said ink container passes a measuring position

wherein said consumption condition calculation process monitors said ink consumption condition in said ink container, and, when it is judged by said consumption condition calculation process that said ink level in said ink container approaches said measuring position level, said piezo-electric device detects said ink consumption condition in said ink container.

39. An ink consumption condition detection method according to claim 38, wherein, when an ink residue on said ink level reaches a predetermined ink residue, said ink jet recording apparatus performs a peripheral operation in accordance with said ink residue.

41. An ink consumption condition detection method according to claim 37, wherein said ink consumption condition is not measured by said piezo-electric device until said ink residue calculated by said consumption condition calculation process reaches an amount in a neighborhood of said measuring position level.

42. / An ink consumption condition detection method according to claim 37, wherein a measuring frequency of said ink consumption condition by said piezo-electric device is

lowered until said ink residue calculated by said consumption condition calculation process reaches an amount in a neighborhood of said measuring position level.

43. An ink consumption condition detection method according to claim 37, wherein a measuring frequency of said ink consumption condition by said piezo-electric device is increased after said ink residue calculated by said consumption condition calculation process reaches an amount in a neighborhood of said measuring position level.

44. An ink consumption condition detection method according to claim 1, further comprising a consumption condition calculation process of calculating said ink consumption condition in said ink container by calculating said ink consumption used in said ink jet recording apparatus, and

wherein said consumption condition calculation process and said detection process of said ink consumption condition by said piezo-electric device are used together, and

wherein said piezo-electric device detects whether an ink level in said ink container passes a measuring position level which is an installation position of said piezo-electric element or not, and thereby detects said ink consumption condition, and

wherein, after detecting by said piezo-electric device that said ink level passes said measuring position level, ink end or no-end is decided based on an average of a plurality of measured results of said ink consumption condition measured by said piezo-electric device.

45. An ink consumption condition detection method according to claim 44, wherein a measuring frequency of said piezo-electric device is lowered until first passing of said ink level through said measuring position level is measured by said piezo-electric device.

46. An ink jet recording apparatus comprising:
a recording head of jetting ink drops;
an ink cartridge of feeding ink to said recording head;
a piezo-electric device of detecting an ink consumption

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condition in said ink cartridge; and

a control unit of controlling said piezo-electric device so as to detect said ink consumption condition when said recording head is in a non-recording state.

47. An ink jet recording apparatus according to claim 46, wherein said piezo-electric device detects changes in acoustic impedance, thereby detects said ink consumption condition in said ink container.

48. An ink jet recording apparatus according to claim 47, wherein said piezo-electric device has a vibration part including a piezo-electric element, and

wherein said piezo-electric device detects changes in said acoustic impedance on the basis of counter electromotive force generated by residual vibration remaining in said vibration part, thereby detects said ink consumption condition in said ink container.

49. An ink jet recording apparatus according to claim 46, further comprising a storage unit of storing said ink consumption condition in said ink cartridge which is detected by said piezo-electric device.

50. An ink jet recording apparatus according to claim 49, wherein said storage unit is mounted on said ink cartridge.

51. An ink jet recording apparatus according to claim 46, wherein said piezo-electric device has a piezo-electric element mounted on said ink cartridge.

52. An ink jet recording apparatus according to claim 46, further comprising a carriage moving with said recording head and said ink cartridge both of which are loaded on said carriage,

wherein said control unit controls said piezo-electric device so as to redetect said ink consumption condition in said ink cartridge after said piezo-electric device detects absence of ink in said ink cartridge when said recording head is in a non-recording state.

53. An ink jet recording apparatus according to claim 52, wherein said control unit moves said carriage after

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detection of absence of ink in said ink cartridge by said piezo-electric device and controls said piezo-electric device so as to redetect said ink consumption condition in said ink cartridge in predetermined timing.

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54. An ink jet recording apparatus according to claim 53, further comprising a shock unit of giving a shock to said ink cartridge during movement of said carriage.

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